# Form ESA-B4. Public Report for ESA-085-3
# (Salt River Materials Group – Clarkdale Arizona)
# Final

| | | | |
|---|---|---|---|
| **Company** | Salt River Materials Group | **ESA Dates** | May 14-16, 2008 |
| **Plant** | Clarkdale, Arizona | **ESA Type** | Compressed Air |
| **Product** | Cement | **ESA Specialist** | Frank Moskowitz |

## Summary Report for the Energy Savings Assessment:

**Introduction:**
As an activity for the United States Department of Energy's Save Energy Now program, an Energy Savings Assessment (ESA) was performed at Phoenix Cement Company, doing business as Salt River Materials Group (SRMG) in Clarkdale Arizona. SRMG is a regional supplier of portland cements, gypsum, and fly ash products. The epicenter of SRMG's service is the cement manufacturing plant located in Clarkdale, AZ where this ESA took place. The plant operates on a 52 week per year, 24 hour per day schedule, and 7 days per week.

Energy sources to the plant include electricity, natural gas and Coal.

The assessment, was conducted May 14$^{th}$ – 16$^{th}$ 2008, and was supported by plant energy manager, Lew Dodendorf. Representatives from management, maintenance, production and finance were also involved. The ESA was led by DOE compressed air qualified specialist, Frank Moskowitz, of Draw Professional Services.

**Honorable Note:** SRMG's cement plant in Clarkdale, Ariz., was honored with the U.S. Environmental Protection Agency (EPA) ENERGY STAR® award for 2007 and 2008.

The plant scored a 97 in 2007 and a 100 in 2008 on the Energy Performance Indicator used by the EPA to establish energy efficiency. In order to qualify for an ENERGY STAR award a score of at least 75 is required. In addition, the plant must have a three-year history of complying with all environmental regulations.

SRMG in Clarkdale Arizona features energy efficient roller mills for coal, raw material and finish grinding. The finish grinding mill was the first such mill to be installed in the U.S. In addition, an energy efficient clinker cooler captures and uses more waste heat in the system. Along with significant energy savings, these improvements allow the plant to reduce emissions and water consumption.

**Objective of ESA:**
The ESA had two main objectives. The first of these was to develop and present viable energy savings opportunities for the compressed air system; the second was to provide hands-on training and demonstration of the process of performing an energy savings assessment. To investigate energy savings opportunities, compressed air system power and pressure data were collected, LogTool was used to process the collected data and AIRMaster+ was used to model compressor energy use and potential energy efficiency measures (EEM's). These activities were performed in concert with site personnel in order to provide hands-on training.

**Focus of the Assessment**:
The assessment focused on the two compressors that were online during the ESA and the pressure profile throughout the production area. (Block diagrams next page). This facility has four air compressors; a 3733 ICFM 800 hp Cooper Turbo Centrifugal compressor which is always base loaded, a 1500 scfm 400 hp Gardner Denver Rotary Screw with turn valve control, a 1500 scfm 350 hp Gardner Denver Rotary Screw with turn valve control and a 2200 scfm 500 hp Gardner Denver Rotary Screw with turn valve control. Discharge pressure is held constant at 115 psig by the Turbo compressor which produces a constant pressure with variable flow. The Turbo ran fully loaded and only the 500 hp rotary ran part loaded (60%) for about 50% of the data collection time. Average flow therefore was approximately (3733 + 660) or about 4,393 cfm. The 800 hp turbo compressor fully loaded can usually support production. However when the pressure to the plant drops to 95 psig, someone has to turn on one of the rotary compressors. No automation exists to perform this task however during the ESA there was a project ongoing to accomplish this task. The pressure setpoint of the Cooper is 115 psig with blowoff occurring at 120 psig. The problem is that the control bands of the rotary's are set higher than this pressure so once a rotary is online, the pressure will never climb high enough to unload it, rather the rotary will push the Cooper into bypass and that's how it will stay until the demand increases enough to once again load the compressor.

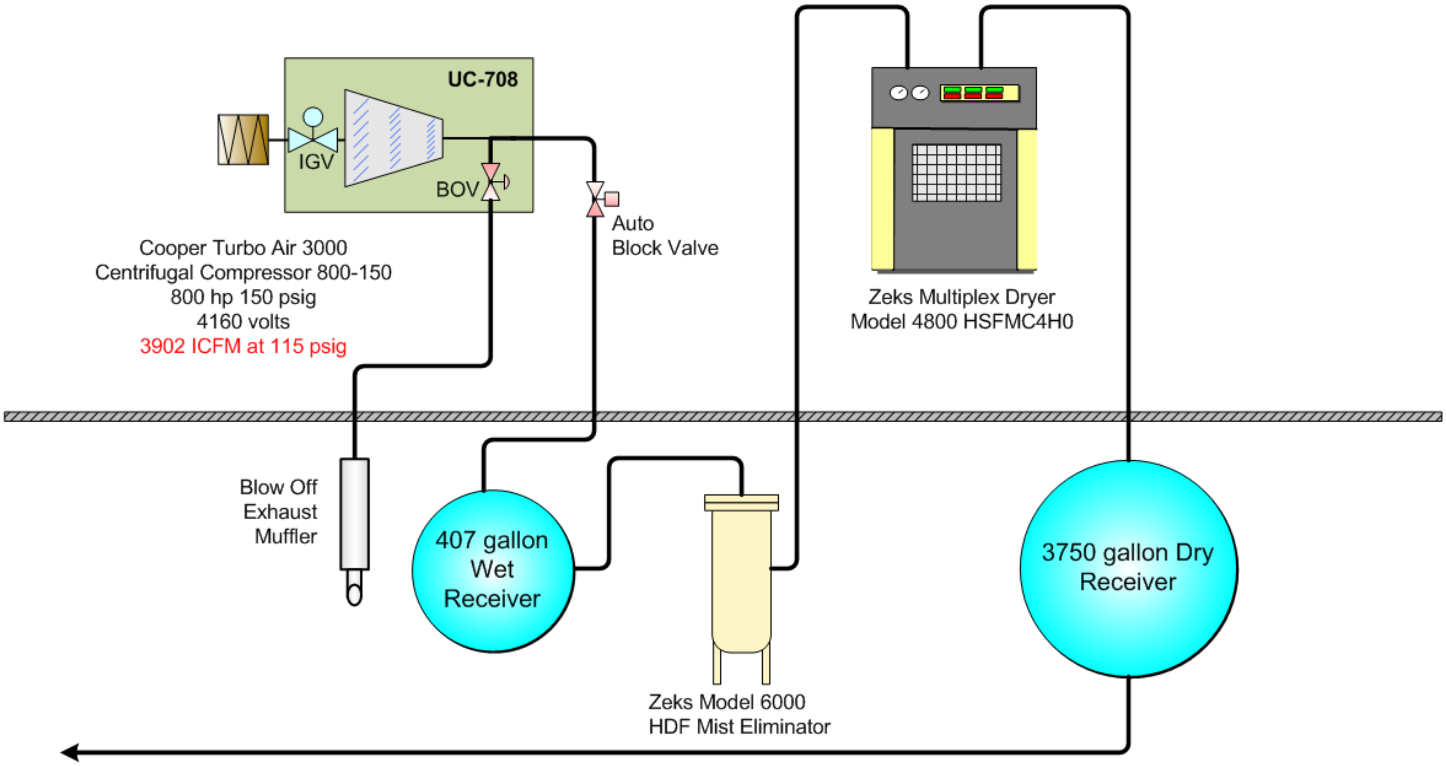
The Cooper Turbo is in a separate location from the other three compressors. A 407 gallon wet tank and a 3750 gallon dry tank serve as volume for the Cooper Turbo. A Mist Eliminator filter and a Multi-Plex dryer clean and dry the air to a dewpoint of 37 degrees F. The air is clean and lubricant free. The three rotaries are housed separately as mentioned. Each discharge to a cycling refrigerated dryer, Mist Eliminator filter and to separate 1020 gallon receivers. This air although free of condensate has the potential for oil aerosol to be present.

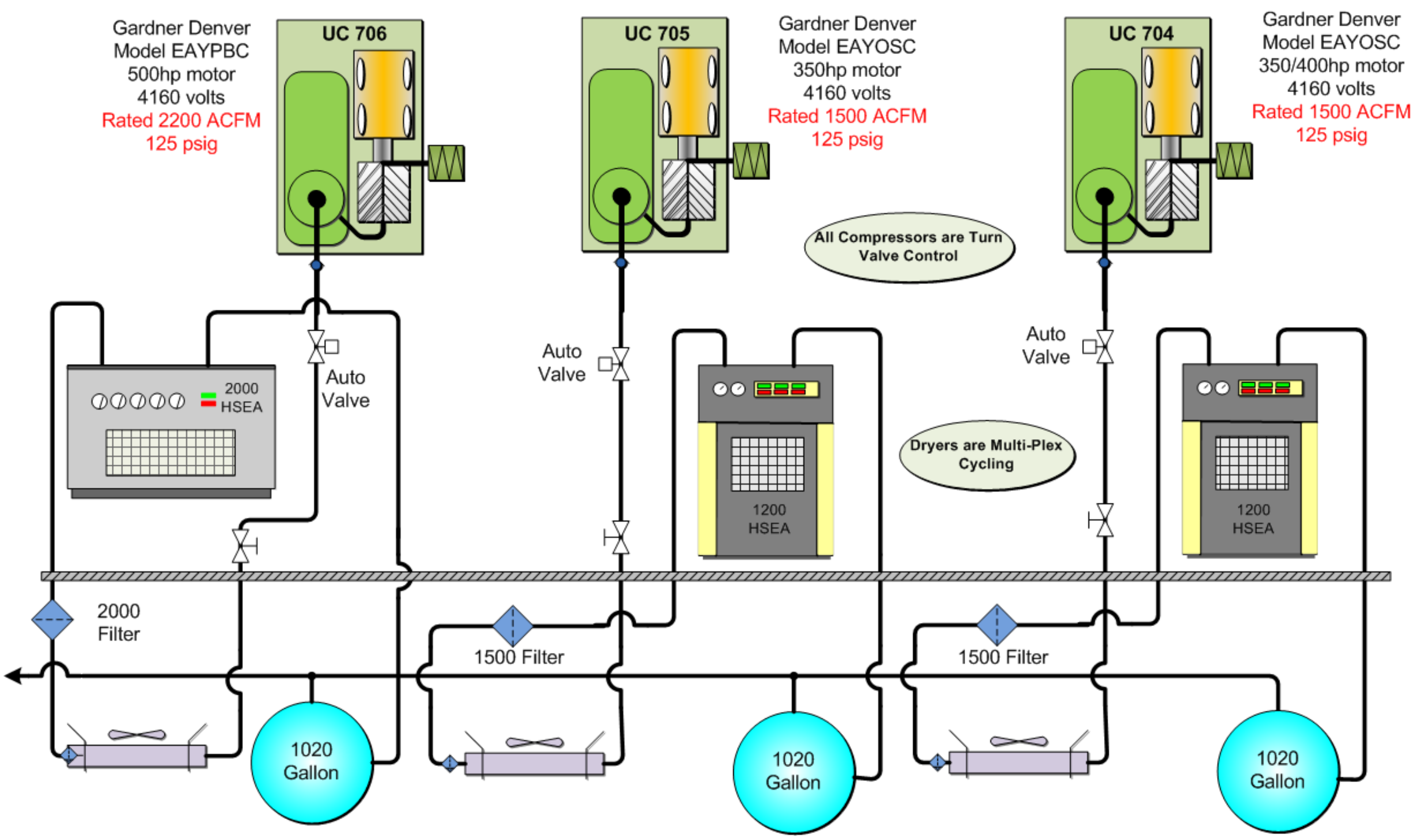
**Approach for ESA**:
The general approach for this ESA included:

- Review of compressed air distribution systems in the plant, including size and type of compressors,
- Review of compressed air support equipment (filters and dryers),
- Discussion of end-uses in the plant,
- Discussion of plant operating schedule and compressor operating schedule,
- Measurement of compressor operating characteristics,
- Brief measurement of compressor and distribution system operations,
- Data analysis with LogTool, and
- Energy analysis with AIRMaster+, including development of EEM's.

Plant personnel were given hands-on training using LogTool and AIRMaster+. Since site personnel will use their own data logging equipment, the DOE representative collected the data for this exercise under observation by plant personnel.

In order to collect the required 48 hours of data which LogTool requires to establish daytypes, all data collection was installed within the first few hours of arriving on site. Site personal were extremely helpful in accomplishing this task. A meeting was held that afternoon to introduce the concepts and routines of the next few days. The stated objective of developing and presenting compressed air EEM's (Energy Efficiency Measures) was accomplished by using compressor operating characteristic data measured during this ESA and using daytype information created by the LogTool software. Information was input to AIRMaster+ and EEM's were developed.




Top diagram is the Cooper Turbo Centrifugal. Bottom diagram are the three rotaries. The discharge lines join somewhere in production.

**General Observations of Potential Opportunities:**

- Total plant natural gas use for base year, 2007 **29,143 DTh / (0.029TBtu)**
- Total plant solid fuel (coal,coke) use for base year, 2007 **108,466 tons/(3.017 TBtu)**
- Total plant electrical use for base year, 2007 **107,859,000 kWh / (0.368TBtu)**
- Note that energy saving opportunities are identified as Near Term, Medium Term, Long Term opportunities. See definitions below:

  - **Near term** opportunities would include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
  - **Medium term** opportunities would require purchase of additional equipment and/or changes in the system such as addition of recuperative air preheaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
  - **Long term** opportunities would require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.

**Opportunities Explained**:

1. **Reduce Air Leaks**. The very nature of a mineral processing or mining operation make leak detection very difficult. Dozens of bag houses, some a hundred feet high, create a near impossible task of identifying where the leaks are. However with a very conservative 440 scfm leak reduction, a savings of 603,546 kWh per year would be the result of this effort.
2. **Improved End Use Efficiency**. Open blowing with hand held blowguns and lances, sparging, diaphragm pumps, open drains, air motors and material fluidizers are ever present throughout production. Some are just plain inappropriate and some are required to make product. However all can be controlled to some degree with substantial savings. Just a 200 scfm reduction from open blowing or air lances will prevent the Gardner Denver compressor from coming on at least 5 hours per day. This equates to 322,938 kWh per year savings.
3. **Use Automatic Sequencer**. Since the controls are overlapping, the Gardner Denver compressor once online, will not unload and timeout. Only a sequencer will force the compressor offline and to shut down once a target pressure has been satisfied. This will insure an additional 253,673 kWh per year savings.

**Management Support and Comments**:

**DOE Contact at Plant/Company: Lew Dodendorf**

*"I want to thank you for the opportunity to conduct the hands on assessment. I wish more facilities could enjoy the in depth look into their operations that we received. Although the time was short it did help in starting a thought process into what kind of things need to be evaluated for running an efficient operation. The information we received will help us achieve our goals toward energy efficiency and reducing GHG emissions. It was great to have an unbiased view of our operations, something that sometimes one does not get from a vendor. It also was good to have someone look at things from a different point of view. I believe the DOE has a great program and I hope the funding will continue to help other industries become more efficient".*
*Thanks,*
*Lew*

**Best Practices Pictures:**

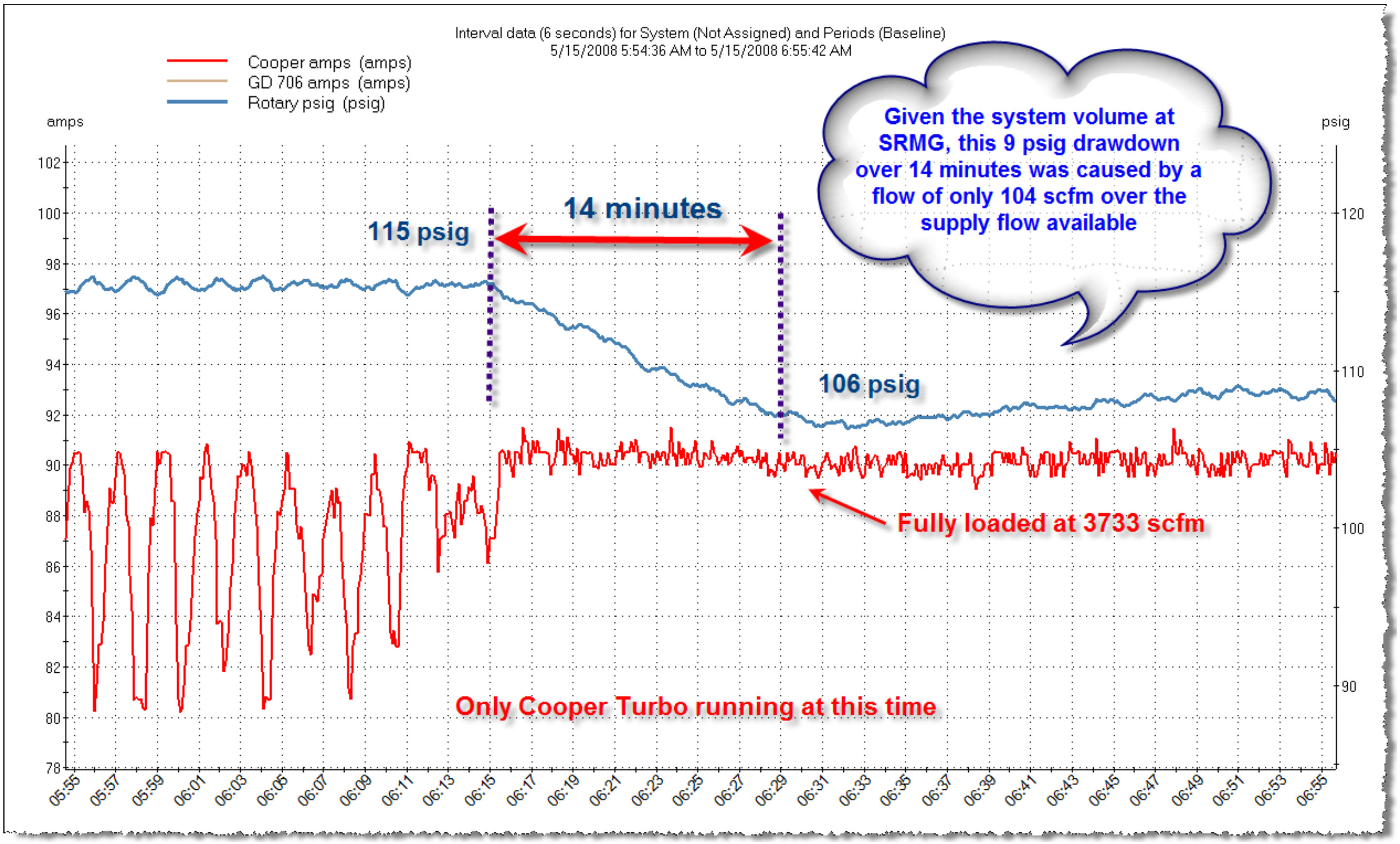
Zero Air Loss Drains Used for Condensate Removal


Energy Saving Cycling dryers used on all compressors

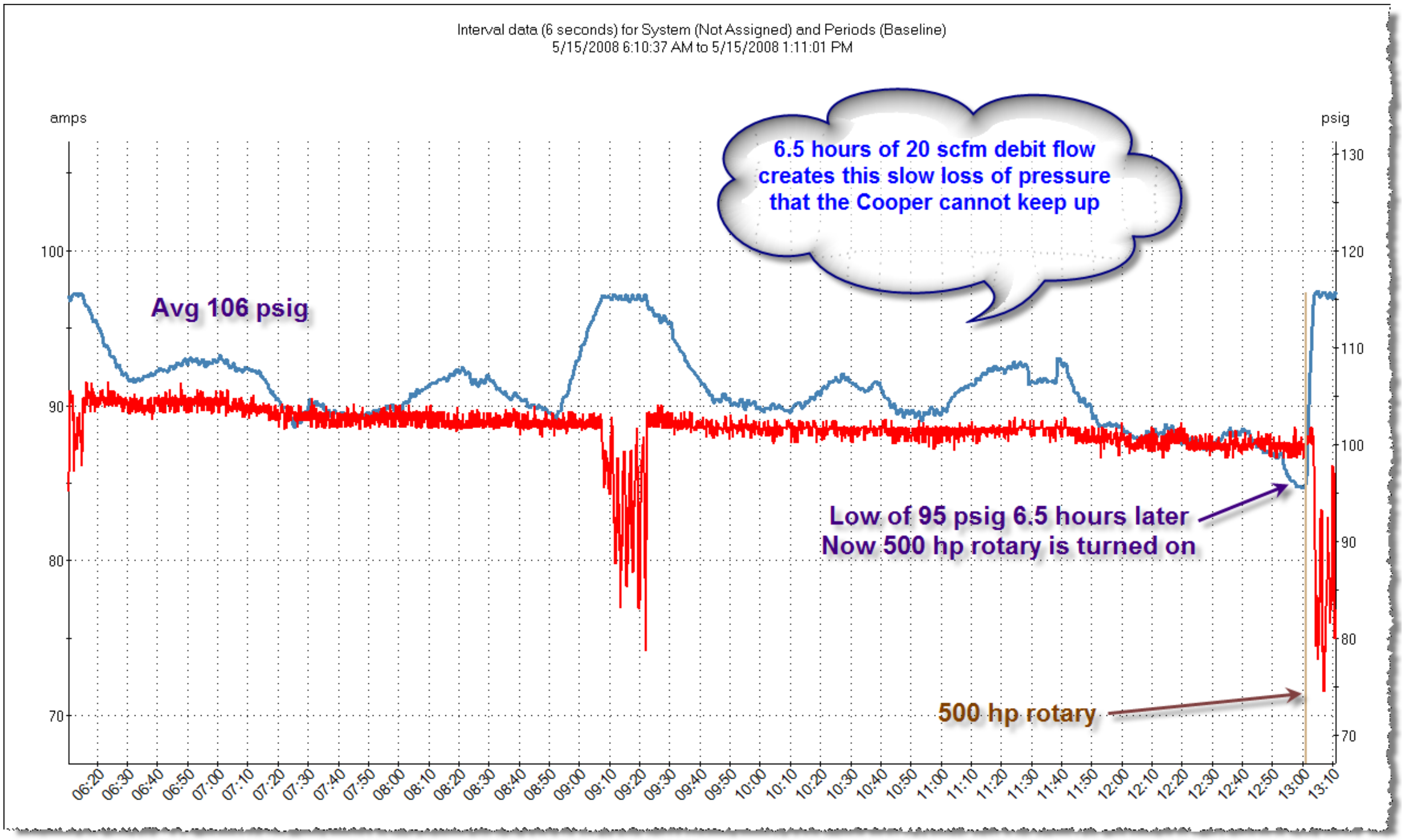
Inlet Guide Vanes on Cooper offer excellent part load turn down

Low pressure drop long life filters used on all compressors

## Log Tool/Airmaster Baseline Information:



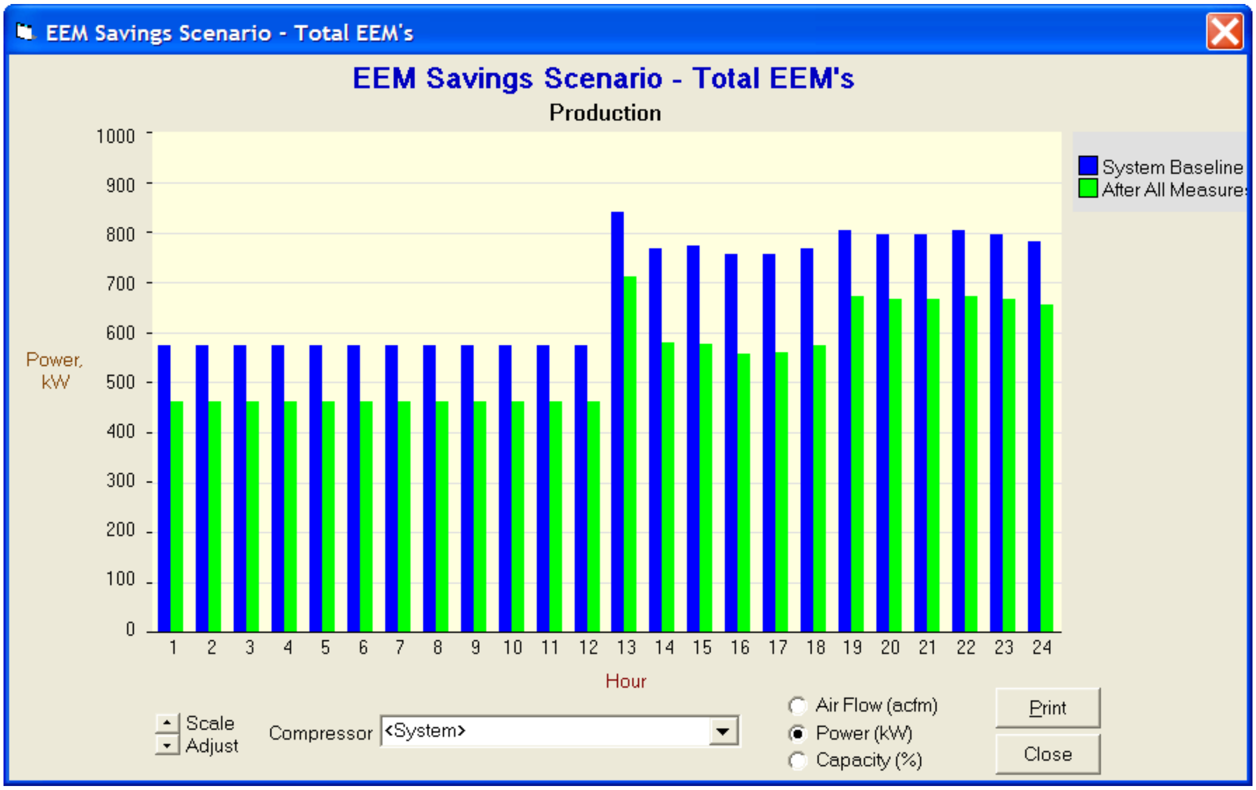

Baseline energy was based on the 800 hp Cooper Turbo running 24/7 and the 500 hp rotary screw operating at 60% load 50% of the time. Chart above shows how close SRMG is to only running with the Turbo if demand can be reduced. Here we see only 104 scfm debit flow above the supply causing a pressure drawdown that will result in the 500 hp rotary being started. Volume was base on 10,730 gallons (1434 cu.ft.) + 3000 feet of 6 inch pipe (588 cu.ft.) for a total of 2022 cubic feet. System capacitance is equal to 2022cuft/12.5psia which equals 161.76 cubic feet per psi. System pressure dropping 9 psig equates to a total volume of 9psig x 161.76cuft/psi or 1455.84 cubic feet. Over 14 min = 104 scfm. On the next page shows a chart of what caused the 500 hp rotary to come on.



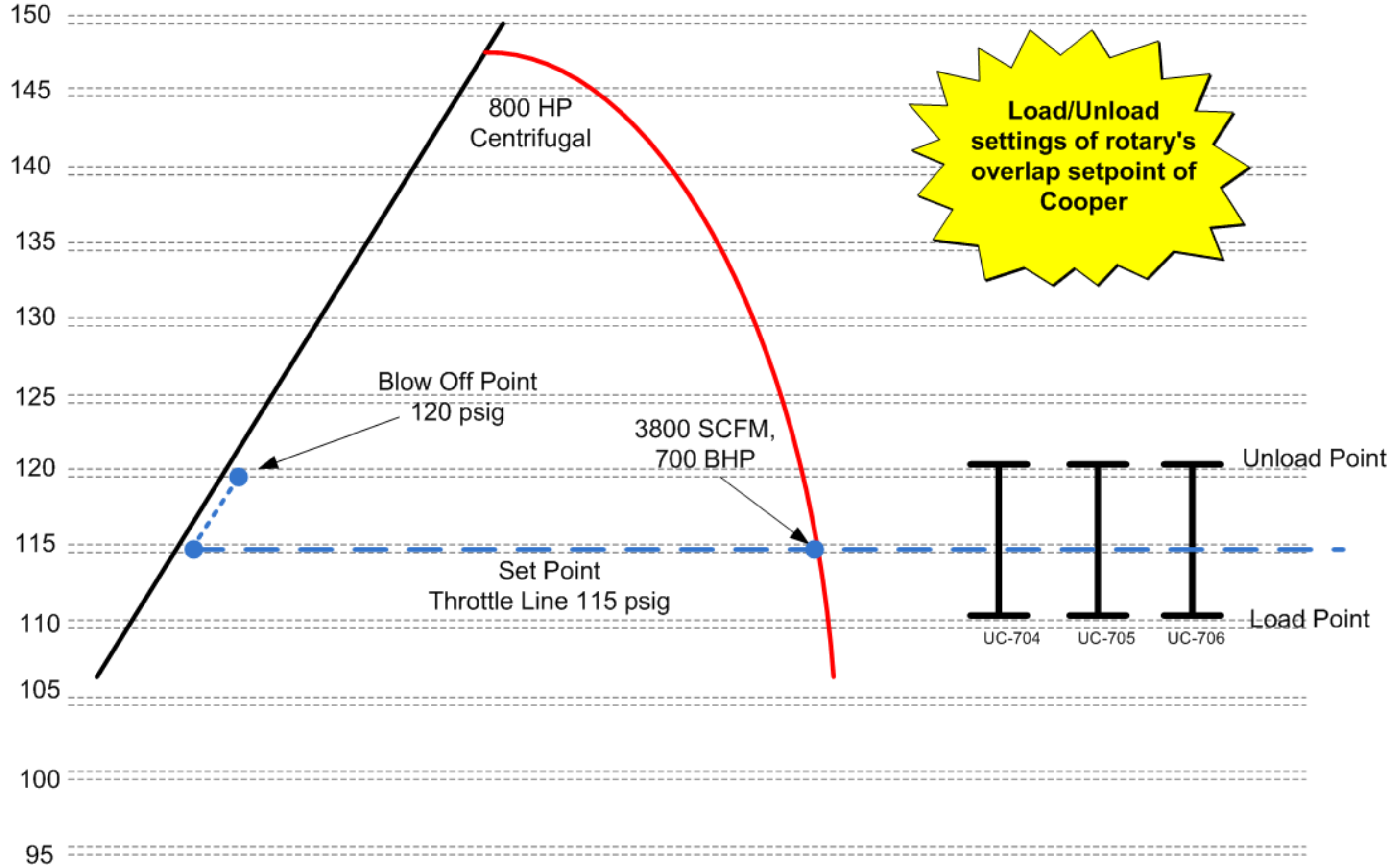

The chart above shows once again how a minimal flow causes a slight pressure drawdown and eventually system pressure reaches a point where someone has decided that production could be impacted. In this case the pressure of 95 psig is the alarm point where one dust collector could be impacted. The question is how much further would the pressure have decayed? The brown line is the amp reading of the 500 hp rotary screw. Once it was turned on it only took 2 minutes for the pressure to rise back to 115 psig which is the setpoint of the Cooper. At this point the 500 hp rotary was left running even as I left the site on day three. Notice how it pushed the Cooper into a part load condition. Although the Cooper is very economical in part load, the 500 hp rotary really did not need to stay on as long as it did. Since it was only a minimal flow that was causing this pressure drawdown in the first place, you can see how important leak repair, wasted air from open blowing and inappropriate uses can cause unexpected energy use.

The EEM's from Airmaster show a direct relationship to the energy savings by reduction of demand requirements. If we can reduce demand at SRMG then we can maintain an acceptable system pressure and hold that pressure with the Cooper Turbo alone. However given the nature of this industry, and the frequent high demands that could occur, SRMG need a reliable sequencer (automation) to control the three rotary screw compressors. A target pressure would be set and only if needed would a trim compressor come online and once satisfied the trim would unload or shutoff as needed. Energy savings from this scenario are shown below.

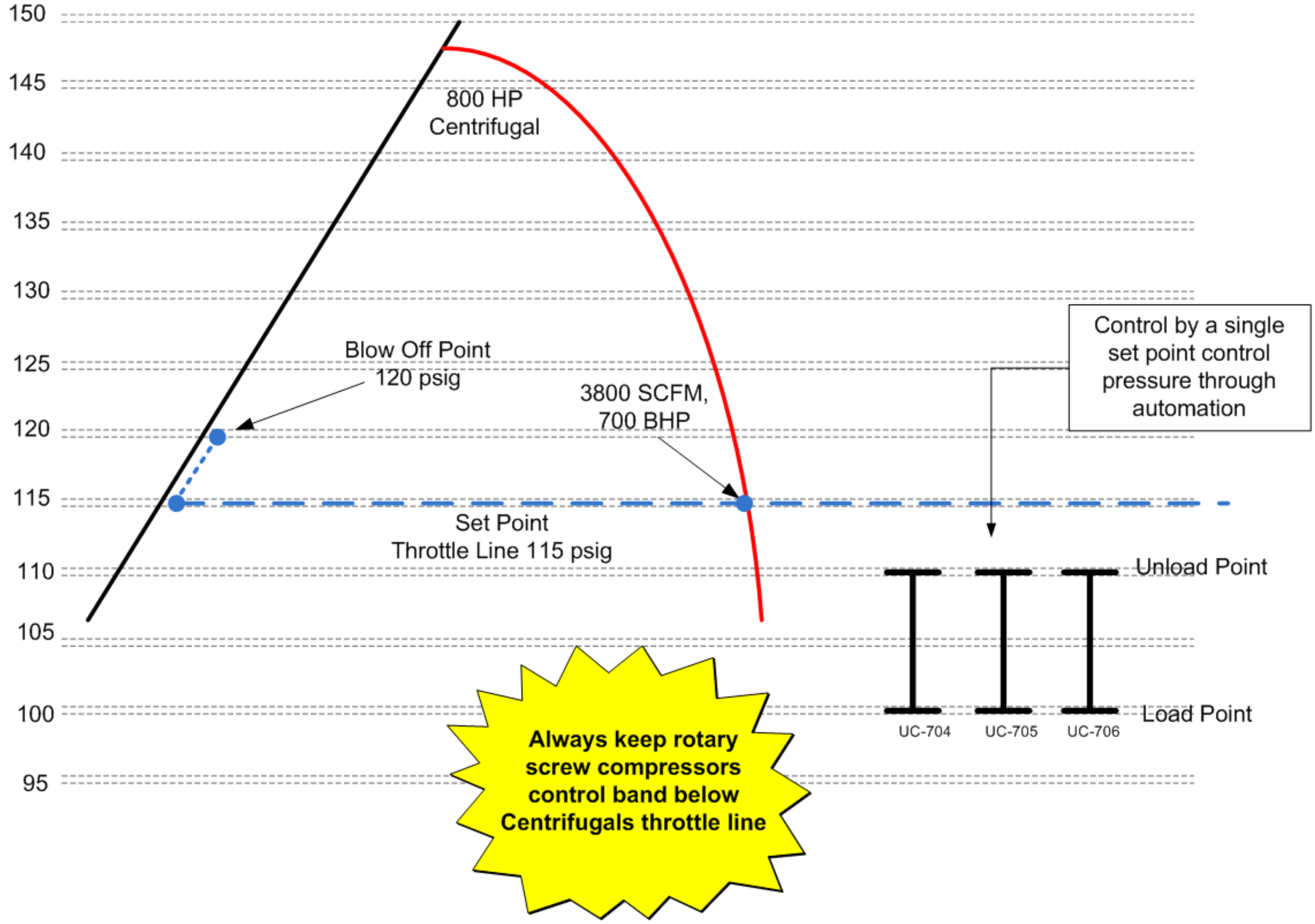
## Energy Efficiency Measures from Airmaster



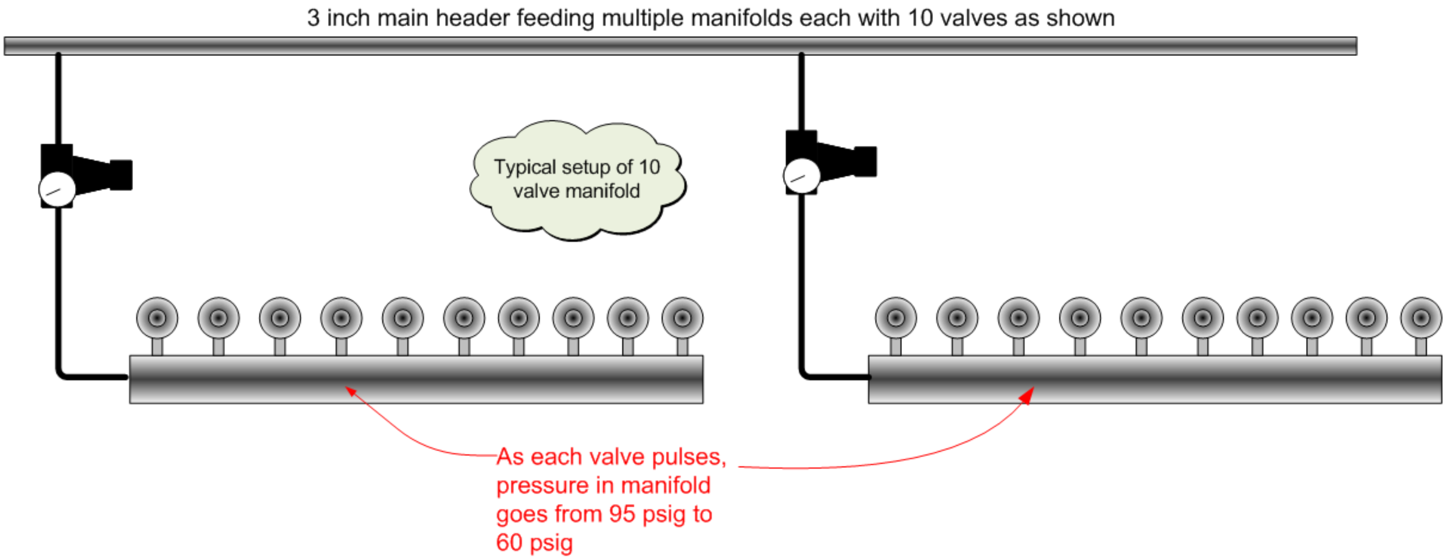
## Control of Compressors Setpoints



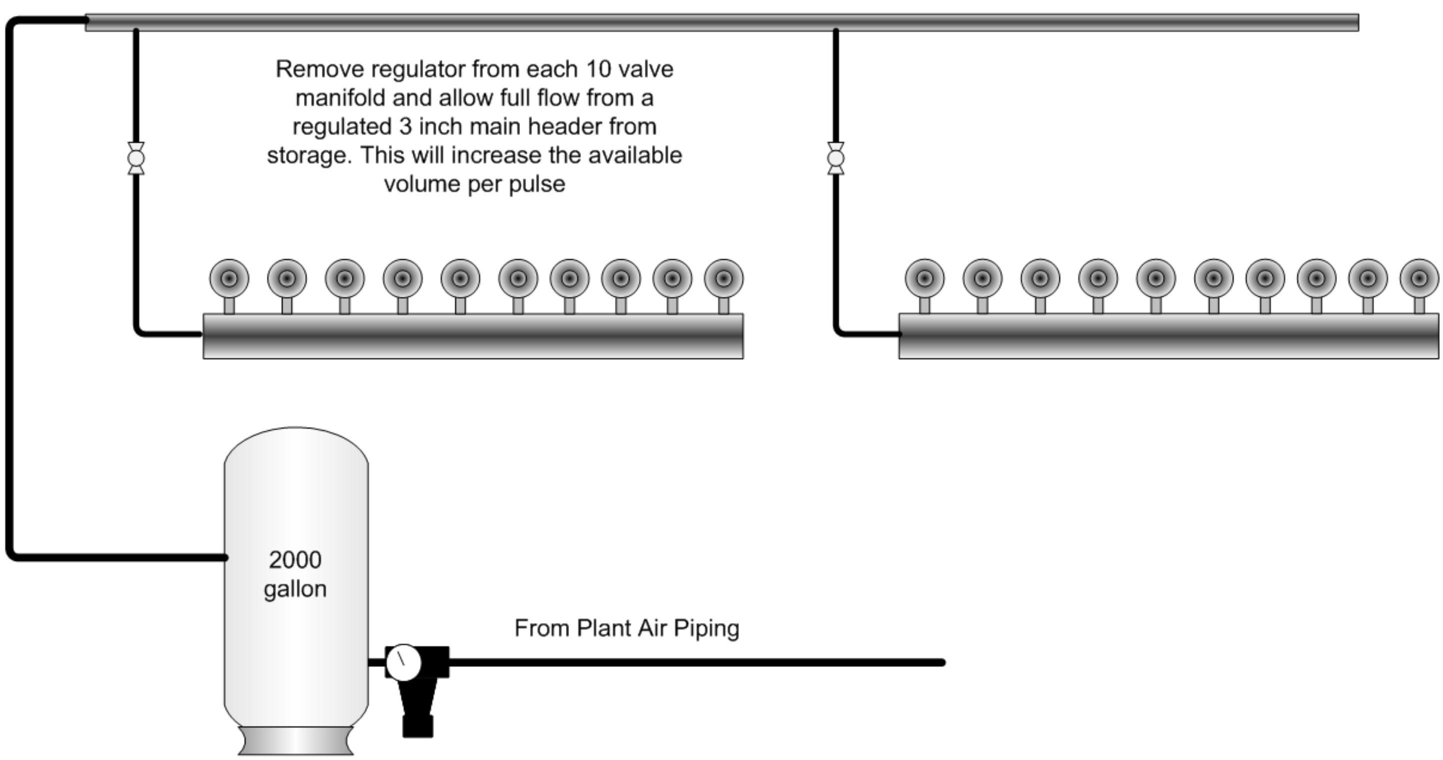

Above chart shows the present control scheme in place. The rotaries are overlapping the throttle line of the Cooper Turbo. Once on, the rotary compressor will never unload. The Cooper dictates the pressure. On the next page would be a modification of this scheme using automation to help control the rotaries.


150
145
140
135
130
125
120
115
110
105
100
95
800 HP
Centrifugal
Blow Off Point
120 psig
3800 SCFM,
700 BHP
Set Point
Throttle Line 115 psig
Control by a single set point control pressure through automation
Unload Point
Load Point
UC-704
UC-705
UC-706
Always keep rotary screw compressors control band below Centrifugals throttle line

## Additional Savings not included in Airmaster -- Dust Collectors




There dozens of dust collectors throughout SRMG. Some dictate the pressure requirements needed in the header. Pictured above is a typical setup of the piping. A 35 psig pressure drop occurs during each pulse. The main problem is lack of volume. If 95 psig is required to pulse, are we really getting this pressure? The answer is no! The regulator feeding each manifold is blocking the available volume. Pictured below is a possible modification of this issue. At the base of the dust collectors there should be a large receiver in the 2000 gallon range. It should have a regulator controlling the max pressure into the receiver. Now we have the volume of the receiver plus piping to feed each pulse. This will allow for a lower pressure to be needed in the plant piping header. Maybe rather than 95 for the alarm we can shoot for 90 psig. All leading towards preventing the trim rotary from coming online for just a few psig.

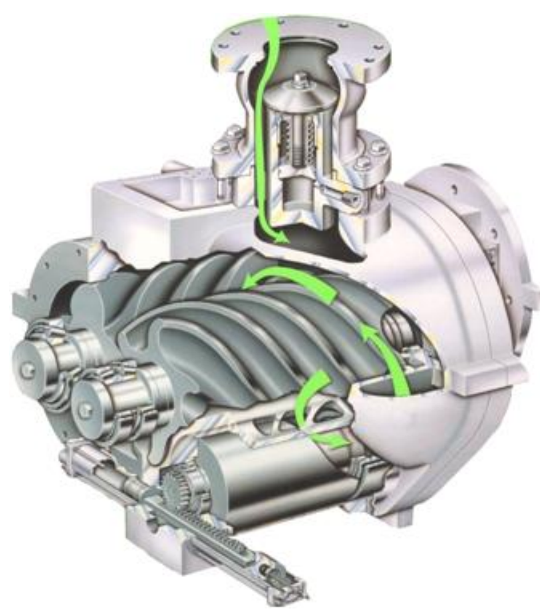


**Additional Savings not included in Airmaster -- Vacuum for cleanup**

Open blowing is commonplace in any industry where dust and dirt are present. It is very easy to plug into a 1 inch line and blow with 100 to 200 scfm and clean an area. If a few employees do this simultaneously the need for a trim compressor to come online is eminent. Pictured right is a vacuum cleaner commonly used in mining industry for spot cleanup. Items such as bucket elevators, screw conveyors, boot seals, etc can be cleaned of debris. Plus if needed the material can be recovered from the 55 gallon drum and either recycled or discarded of properly. Although the unit runs off compressed air, the flow requirements are 1/10th the requirements of a 1 inch open blowing lance. Something to think about as SRMG tries to reduce compressed air waste.


**Compressor Performance:**

It was discussed in a meeting that the three rotary screws cannot produce enough flow to create a pressure that will support productions needs. The three rotaries total 5200 acfm. De-rated for altitude would be 4400 scfm. This is slightly more than the requirements during the ESA. Therefore the three rotaries should indeed support production. One reason why they would not would be a malfunctioning turn valve. This type of control is known as “Variable Displacement” and it allows progressive reduction of the compressor’s displacement without reducing inlet pressure. See pictures below. The valve can reduce the flow up to 50% so this is not something you would want stuck!



**Conclusion:**

SRMG is well on their way with improvements to their compressed air system. They learned about optimizing the compressed air system as well as proper control of compressors. Base loading the centrifugal is the most economic way to run with the rotaries as trim only. Automation and not pressure switches needs to control the trim compressors.

The Energy Savings Assessment (ESA) at the Clarkdale Arizona plant was a huge success. The benefits of the session will hopefully reach all management. Many people participated in the assessment. The team consisted of Manufacturing, Maintenance, Process and Technical Leaders.

During the session, participants:

- Received a compressed air training overview,
- Learned to use the DOE's software tools to identify energy-saving opportunities and to optimize their compressed air systems,
- Identified best practices that can be shared across the company,
- Identified and generated a list of energy-saving opportunities for the Clarkdale plant.